SCIENCE

VOL. 84 FRIDAY, SEPTEMBER 25, 1936 No. 2178

The Nervous System: DR. EDGAR DOUGLAS ADRIAN 275
Summary Statement of the Work of the National Research Council: DR. FRANK R. LILLIE 278
Scientific Events:
The International Union of Geodesy and Geophysics; The Pittsburgh Meeting of the American Society of Civil Engineers; The Summer Meeting of the American Mathematical Society; The Debt of Industry to the Universities; Degrees Conferred at the Harvard Tercentenary Celebration; Recent Deaths 283
Scientific Notes and News 287
Discussion:
Significant Figures in Statistical Constants: PROFESSOR EDWARD B. ROESSLER. *Paramecium Multimicronucleata vs. Paramecium Multimicronucleatum:* PROFESSOR JOHN A. FRISCH, S.J. *Trochospongilla horrida in Arkansas:* DR. DAVID CAUSEY and HAROLD EIDSON. *Wanted: A New Word:* DR. ROBERT T. MORRIS 289
Special Articles:
The Ultracentrifugal Concentration of Pneumococcic Antibodies: DR. RALPH W. G. WYCKOFF. *Earthworms as Test Objects for Determining the Value of Drugs to be Used in Human Intestinal Helminth Infestations:* DR. PAUL D. LAMSON and CHARLOTTE B. WARD. *Catalysis of Formaldehyde to Reducing Sugars by Ascorbic Acid:* PROFESSOR EDWARD S. WEST and LUMAN F. NEY. *The Condensation of β-Cyclocitral with Dimethylacrolein:* PROFESSOR REYNOLD C. FUSON and DR. ROBERT E. CHRIST 291
Scientific Apparatus and Laboratory Methods:
The Regal Lily as a Source of Root-tip Material: PROFESSOR LAWRENCE E. GRIFFIN and JANE DAY. *A Device for Short Photographic Exposures:* DR. RODERICK CRAIG. *A Laboratory-made Blast Lamp:* C. ROBERT MOODEY and ARNOLD LOWMAN 295
Science News 6

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE NERVOUS SYSTEM[1]

By Dr. EDGAR DOUGLAS ADRIAN

UNIVERSITY OF CAMBRIDGE; FOULERTON PROFESSOR OF PHYSIOLOGY OF THE ROYAL SOCIETY

THE lower creatures do not meet to discuss the factors which determine their behavior. "Know thyself" is a precept reserved for *homo sapiens;* indeed the more academic our discussion the better we shall demonstrate our true position in the animal kingdom.

We are animals with powers of reflection and foresight, who can use tools and form propositions. Our knowledge and attainments can increase from one generation to another because our children can learn from our successes and failures. In the last hundred years we have found out so much about the material world that we have acquired immense new powers of action on it. What have we found out meanwhile about ourselves?

There have been no practical achievements comparable to the radio set or the flying machine, but no one can doubt that ideas about human behavior are vastly different from what they were over fifty years ago. Our conduct is no longer as right or wrong as it was. We think of it still as the outcome of a conflict between opposing forces, but we do not postulate forces wholly good and wholly evil. In some lands they are now thought of as racial or class instincts: here we have more choice and are free, if we wish to see ourselves driven by the more primitive forces which Freud has made respectable. But everywhere human behavior has become something to be studied by the methods of natural science, as objectively as possible.

As a foundation to this study there is a mass of information about the mechanism of the body. The behavior of any animal must depend in part on general structure—its shape, size, number of limbs, arrangement of sense organs, etc., and with man there

[1] Given at the Harvard Tercentenary Conference of Arts and Sciences, Cambridge, September 7, 1936.

are the important structural modifications which allow the forelimbs to be used for wielding tools. Yet the chief factor which determines the range of our activities is the nervous system. Every movement is the result of the messages which pass from the central mass of nerve cells to the muscles, and the outgoing messages are varied according to the reports submitted by the sense organs. These show what is happening in the world outside, and the central nervous system must evolve a plan appropriate to the occasion. But only the simplest plans are possible if the central nervous system is ill developed. The earthworm can take to its burrow when it feels the shock of footsteps on the grass and such an immediate reaction needs only a few hundred nerve cells and fibers; but we can sell out an investment when we hear rumors that the company is unsound, and this reaction needs the ten thousand million cells of the human cerebral cortex.

Our concern is with behavior of this characteristically human type. It represents by far the most complex synthesis achieved by any nervous system. Neurology, therefore, is not to be blamed because it can not yet analyze such a product into an affair of nerve networks and impulses. But from one aspect human behavior is an affair of networks and impulses; it may be useful to picture it in these terms in spite of the fact that we know far more about our thoughts and actions than we do about the mechanisms in our brains.

The central nervous system may be divided into the forebrain, the cerebral hemispheres which elaborate the general plan of behavior and the brain stem and spinal cord which have to carry out the plan and attend to the administrative details. The whole system is made up of cells with thread-like extensions, some running as nerve fibers to the periphery and some forming the interlacing networks of the central apparatus. The cells and their extensions are excitable; within them are stores of available potential energy, ready to be discharged as soon as the restraining forces are weakened but replenished as soon as the discharge is over. All nervous activity involves discharges of this kind. Thus the long distance signalling from sense organs to brain and from brain to muscles is carried out by the conduction down the nerve fibers of repeated impulses, momentary waves of activity traveling like the spark along a fuse, and everywhere in the nervous system is liberated in brief outbursts rather than in a continuous stream. This fact by itself has little bearing on our actions, save that it sets an upper limit to the rate at which activity can change. What is of more importance is the fact that in some nerve cells the outbursts seem to occur spontaneously, without the need for an external stimulus to start the discharge.

The best example is the respiratory center, the group of cells in the brain stem which controls the rhythmic movements of breathing. For these cells the normal state is one in which periods of rest and activity alternate regularly. There are various devices for controlling the rhythm and prolonging one or other phase to suit the convenience of the organism, but the regular cycle must return in the end, and it is due, not to a sequence of reflexes, but to the cycle of breakdown and repair in the nerve cells. The movements of walking and running are determined in the same way by an automatic rhythm in a group of nerve cells. With these, however, the organism has a greater measure of control and can start or stop the rhythm by the appropriate signals. The work of Coghill and others on the development of behavior in the embryo has shown that many complex activities have this same semi-automatic origin, the outside world giving signals to begin and end and the complex organization of the nerve cells supplying all the detail.

Admittedly there can be no real separation of activities which are spontaneous from those which are evoked by the environment. It is of interest none the less to find that the region in which spontaneous activity seems most ready to occur is in the great surface network of the forebrain—the cerebral cortex. Even in deep anesthesia the cortex is alive with the electrical pulsations which are the index of nerve cell activity. They vary from a simple rhythmic beat to an irregular succession of waves. The latter are not merely a reflection of the irregular world outside, for the anesthetic has cut off all incoming sensory messages; they are due rather to the automatic discharges of nerve cells, linked together, but differing in position and structure and in the past history of their activities. In these cells a steady state is impossible because their internal tension is constantly increasing to the point of discharge.

Although the cortex can not be kept completely at rest for more than a few seconds, the degree of activity in it can vary enormously. The variations are due in part to the world outside and in part to the internal necessities of the nerve cells. Activity in one cell tends to foster activity in its neighbors and so to build up the general level of excitation. The level will rise until the process is checked by the falling reserves of available energy. Similarly, rest breeds rest, and this process is checked by the internal tensions rising ultimately to the point of breakdown. The sudden increase of activity when we wake in the morning illustrates the change of level brought about by external stimuli acting on a recharged nervous system, though other factors are concerned as well. Inhibition,

The process by which one cell can suppress instead of enhance the activity of other cells, is no doubt a factor which helps to shift the focus from one part of the cortex to another. In general, however, we may think of the forebrain as a complex society of nerve cells, the units of which can not remain for long either in intense activity or in complete rest.

These electrical changes give a picture of cerebral activity which recalls certain features of mental activity. The environment can start or stop a train of thought and keep it within certain channels, yet the sequence of ideas is often dictated almost entirely by past events, and certain sequences seem to obtrude themselves unbidden. Such comparisons are dangerous, for they suggest that we have already a reasonable knowledge of the connection between mental and neutral events, whereas in fact we know almost nothing. We can be sure, nevertheless, that the connection is extremely close.

The activity of the cerebrum, determined largely by the past and continually changing even in a steady environment, is in sharp contrast with that of the rest of the central nervous system. This has no memory. Its function is to carry out the plans dictated by the cerebrum and at the same time to keep the machinery of the body running smoothly. It must regulate the intake of food and oxygen, the circulation of the blood, its temperature and acidity. It must keep the body in its correct position in space, balancing it in spite of its shifting center of gravity. It must minimize the disturbances which are likely to result from great exertion or injury. For all this there is a beautiful reflex machinery coordinating the messages from sense organs specially adapted to register the blood pressure, the tension in muscles, the pull of gravity, etc. But an animal without its cerebrum is no more than an automaton: it can stand and breathe and live after a fashion, but its behavior is reduced to a number of reflexes or, at the most, habitual patterns of action.

Long ago Claude Bernard insisted that the internal environment must be constant if life is to be unrestricted. His dictum has been supported lately by two distinguished physiologists from the two Cambridges. Cannon has shown how the visceral nerves prepare the body for sudden emergencies, and Barcroft has studied the factors which lead to a breakdown of normal activity. It is significant that man has more need of a constant environment than any other animal, since it is the cerebrum which has the most delicate organization and can least withstand any change.

Human behavior, then, is preeminently the affair of the cerebral cortex. This is made up of the same structures as the rest of the nervous system, though there are more nerve cells in it, larger networks, in proportion to incoming and outgoing pathways and more spontaneous discharge. What is new is its power to combine past activity with present. As Sherrington has said: "The great new surface net of the brain is educable. Before it, truly, there were educable systems in the animal world, but this is so educable as to be practically a new thing in the world. In the dog it can acquire new links even in a few repetitions and links can be combined even to the third degree. In man it seems they can develop almost without limit."

The cortex can learn and can use its learning to generalize and to solve new problems. But even the simplest kind of learning involves a factor which must still be expressed in psychological terms. As Pavlov's work has shown, there must be interest, a prospect of reward or punishment, an emotional stress which will change to satisfaction when the lesson is learned or the problem solved.

We are still quite ignorant of the neural changes which take place when new associations are formed in the brain, and we can only guess why an incentive is necessary. Twenty or even ten years hence we shall know much more, for there are definite changes in the electrical activity of different regions when we direct our attention from the visual field to the auditory and *vice versa*. These are not beyond analysis. It is perhaps too much to hope that in revealing the neural mechanism of attention they will reveal that of consciousness as well, but at least they may show what kind of influence is exerted by emotional interest and why that influence is exerted on particular mental and neural sequences.

We may guess that the state favorable to learning involves an increase of excitability and possibly a change in the chemical environment of those parts of the brain in which the new connections are established; and probably it is brought about by the more primitive parts of the forebrain, the hypothalamus and the basal ganglia. These regions prepare the nervous system for its cycle of sleep and waking; they are linked with the hormone system and they control various kinds of instinctive and emotional behavior. Sinister proof of their importance comes from cases of injury or disease. But whatever the regions concerned, it is safe to assume that there must be some activity on the emotional or instinctive level to direct the attention and prepare the brain for new associations.

For discriminating behavior, therefore, there must be some interest. Yet, if there is too much, the behavior will cease to be discriminative. Under intense emotional stress the behavior tends to conform to one of several stereotyped patterns. These are managed by the more primitive parts of the forebrain, and the cortex has little to do with them beyond directing the behavior towards a particular object. Thus a cat

whose cortex has been destroyed may give all the signs of rage, though it is a blind rage and useless to the animal. With the brain intact the rage is directed. It is still a stereotyped response, but it is often the best response for the cat to make, since its cortex has not the capacity to plan more elaborately. In man, however, the cortex, when it is allowed free play, can be far more patent, and emotional reactions which force the behavior along one line and allow no scope for discrimination are far less so. Moreover, emotional reactions tend to spread through all the members of a group and to build themselves up to higher and higher levels.

There is no need to pursue a devious argument to its certain but commonplace conclusion—that our behavior will be most effective when there is enough emotional tension to arouse the activity of the forebrain but not enough to submerge it in a stereotyped response. We know well enough that our emotions can cloud our judgment, and the psychologists have shown that they do so far more than we suspect. We know that some interest is necessary, that moral indignation supplies the driving force for great reforms, but that rage does not help them. Need we care greatly whether the neurologist can produce a scheme of nervous mechanism which will account for these things?

Most of us, I think, would welcome the knowledge gained, but we might reasonably doubt whether it would make us more effective units of society. It is, in fact, unlikely that neurological research will give new methods of control over human behavior. What it will certainly do is to improve some of the methods which exist already—for instance, the control of behavior by drugs. Tea and alcohol are homely examples, and the new narcotics which can give peace of mind before a surgical operation have shown what we may expect in future from this method of regulating our brains. For more continuous action there are the drugs which the body manufactures for itself—the hormones. These, fortunately, have a place reserved to themselves in to-day's discussion.

But when all is said, a knowledge of physiology offers only one certain, though perhaps unattainable, method by which human behavior could be improved. That is to breed men with larger brains. Our cerebral hemispheres are not so much larger than those of the chimpanzee and contain no new structures, but our behavior is of a different order. We can pile one box on another without thinking; Professor Köhler's chimpanzees could succeed by chance, but the essentials of the problem were quite outside their mental range. It is tantalizing to think of the new relations we should see, of the new world of thought we should live in, if our brains were but twice their present size. Our behavior would then be superhuman! it would be determined by the same physiological factors, but the importance of the cortex would be so magnified that the result must be beyond the power of human thought.

SUMMARY STATEMENT OF THE WORK OF THE NATIONAL RESEARCH COUNCIL

By Dr. FRANK R. LILLIE
CHAIRMAN

THE annual report of the National Research Council is printed each year in the Report of the National Academy of Sciences, a Senate Document, by the Government Printing Office in Washington. As the report for the year ending June 30 usually appears in April of the following year, and is relatively inaccessible to the scientific public, a summary statement of the year's work has been published in SCIENCE in recent years.

The past year completes the twentieth year of operation of the National Research Council since its organization by the National Academy of Sciences in the summer of 1916 after the academy had offered its services to the Federal Government in the interests of national security. Since the termination of the world war the Research Council has endeavored to serve the interests of scientific research in this country as a mechanism of coordination operated by American scientific men themselves, in relation to academic, industrial and governmental interests in science. It is clear that the Council has little, if any, effectiveness apart from the use which these men may make of the facilities of such relationships, under the auspices and coordinated support which it offers.

The National Research Council is an agency of the National Academy of Sciences and operates under its Congressional Charter of 1863. During the year just passed the president of the academy acted also as chairman of the National Research Council. At the close of the year this arrangement was terminated, and Dr. Ludvig Hektoen, of Chicago, was elected chairman of the National Research Council.

I. GENERAL RELATIONS

GOVERNMENT RELATIONS

The charter of the National Academy of Sciences provides among other things: "The Academy shall, whenever called upon by any department of the government, investigate, examine, experiment, and report upon any subject of science or art." In order to be better prepared to meet these responsibilities a Government Relations Committee was set up in the National Academy of Sciences in 1925.

The executive order by President Wilson in 1918 requesting the Academy of National Sciences to perpetuate the National Research Council also strongly emphasized government relations, and pointed to the duty of scientific men to cooperate actively with the scientific and technical services of the various departments of the National Government.

From 1933 to the end of 1935 the National Research Council cooperated closely with the Science Advisory Board which was set up under executive order of President Roosevelt "acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council to appoint committees to deal with specific problems in the various departments." The important work of this board under the chairmanship of Karl T. Compton is well known and is recorded in their published reports.

With the expiration of the period of appointment of the Science Advisory Board on November 30, 1935, its functions were combined with those of the Government Relations Committee of the academy in a new committee known as the Government Relations and Science Advisory Committee, related both to the Academy and the Council. This committee, which centralizes the federal relations of Academy and Council, is composed of twenty-four members with a smaller internal executive committee comprising a majority of the members of the Science Advisory Board; it has taken over certain continuing committees of the latter, and has appointed other committees on request of government departments.

Among these enterprises are the appointment of advisory committees to the Weather Bureau, to the National Bureau of Standards and to the Soil Conservation Service, certain assistance to the Navy Department, a study of the relationship of the United States patent system to the stimulation of new industries, the improvement of means for signalling for safety at sea, particularly in cases of fog; and means for the comprehensive abstracting of scientific literature in the field of biology. A report of a committee of the Science Advisory Board, completed last July for the Navy Department, on the design and construction of airships definitely recommended further experimentation in the construction of lighter-than-air aircraft with a view to the successful development of this method of transportation.

The National Academy of Sciences is also represented on the Science Committee of the National Resources Committee operating under executive order by President Roosevelt; and through this relationship is brought into contact with problems of general national importance, in which the outlook and resources of science are assuming increasing significance.

FELLOWSHIPS

The national research fellowships administered by the National Research Council with funds supplied by the Rockefeller Foundation since 1920 have proved to be one of the very strong factors in the recent development of scientific research in America. Many of the past fellows have earned distinction, and occupy leading positions in academic life, in research laboratories and government bureaus. The system of providing opportunity for uninterrupted research after attainment of the doctor's degree has come to be a settled factor in the American plan of training for advanced scholarship. Under the National Research Council during the current year (1935–36), 56 fellows were working in the physical, medical and biological sciences; 49 appointments have been made for the following year. These are much smaller numbers than previously, when there was a much larger potential outlet in academic fields for such highly trained individuals. Other agencies have entered the field of post-doctorate training in the meantime; and there seems no reason to expect a decrease of opportunity for advanced study on the part of really gifted and enthusiastic candidates. The leading part played by the National Research Council may be expected to continue, though on a smaller scale. To have led the way in the development of this essential addition to the older plans for advanced training has been a much prized privilege of the National Research Council.

A stage of transition has been reached in the administration of these fellowships, as in so many other affairs; and the experience gained in sixteen years must now be utilized in adapting the system to the new conditions with which we are confronted.

ABSTRACTING AND DOCUMENTATION OF SCIENTIFIC LITERATURE

The Council has long been concerned with this fundamental need of scientific research. Among other activities it fostered the establishment of *Biological Abstracts*. The financial difficulties of this indispensable journal, the rapid growth of scientific literature and the evidences of future different methods of scientific publication combined in a decision to hold a com-

prehensive conference on the subject, including in its membership editors of abstracting journals, librarians, publishers and other interests. The subjects considered were the place and function of abstracting and indexing in scientific documentation, the form and content of abstracts and the use of analytical indexes, the fundamental delimitation of fields and their relation to specific subjects, the methodology of abstracting and indexing, and means for the reproduction and distribution of abstracts.

As a result of this conference, which was held in Washington on December 9 and 10, 1935, a standing committee of the National Research Council was appointed "to represent the various scientific Divisions of the Council, with instructions to prepare and present a long-time program looking toward the effective support of abstracting agencies in the several fields of science."

Integration of the Sciences

Dr. Bowman, in his "Summary Statement of the Work of the National Research Council for 1934–35" referred to the consideration which had been given by the Administrative Committee to borderlands between the traditional scientific fields. This consideration has led to the formation of an interdivisional committee on borderlands in science between the divisions of physics, chemistry and geology. A similar committee in the biological sciences, if formed, would integrate numerous overlapping interests between biology, psychology and anthropology and the medical sciences.

These should be promising aids to the integrating functions with reference to the natural sciences, which it is the business of the National Research Council to exercise. The present time is an age of integration in which the functional, as contrasted with the purely logical, aspects of science are coming to the fore. There is an insistent urge to utilize all scientific knowledge obtainable for the public welfare in the innumerable ways now open for the application of knowledge in industry, in governmental administration, in public welfare and in other portions of our social order. Such problems do not accommodate themselves to the limits of the traditional fields of learning. They invade several fields at once and demand contributions frequently from a varied group of scientific men. Integration of knowledge from varied sources, brought to bear upon a single social purpose or end, is characteristic of the present scientific situation.

International Relations

The international unions to which the Council now adheres are the International Astronomical Union, International Union of Chemistry, International Union of Geodesy and Geophysics, International Scientific Radio Union, International Union of Pure and Applied Physics, International Geographical Union and the International Union of Biological Sciences.

It is gratifying to be able to report that the Federal Government through the Department of State is again undertaking the payment of dues in the International Council of Scientific Unions and that the continued participation of the United States in these essential coordinating mechanisms of international science thus seems assured.

Central Purposes or Functions

Whatever may be accomplished by the Divisions of Science and Technology in their respective fields certain central functions can be served only by the Council as a whole. Finance and administration is one on which all other functions depend. This granted, the main central function is to provide the auspices under which the scientific men of the country may meet to consider the promotion of research broadly or in special fields. Out of this all else will flow. Provision must, of course, be made for the meetings of the various administrative bodies. But, quite apart from that, the budget of the Council must make provision for rather frequent conferences of non-administrative kind. Funds for this purpose have been set aside for a series of years, and it is hoped that it may be possible to increase funds devoted to this purpose. A second central function in which the academy and council cooperate is the maintenance of appropriate government relations referred to above. This also requires special budgetary provision. A third central function is the support of special international scientific undertakings, in which the National Research Council should be able to cooperate.

II. THE DIVISIONS OF SCIENCE AND TECHNOLOGY

The preceding statements have dealt with certain general relations of the Council; but many activities of the Divisions of Science and Technology are of general interest. The following items are selected in a rather arbitrary fashion without reference to the separate divisions under which they are administered. As the number of committees under these divisions amounts to fifty-five it is only a small selection. Moreover, it omits entirely the broader divisional interests which are constantly pursued. It should be said that the divisions are very active organizations in contact with the leading developments of their respective fields.

Electrical Insulation

The growth of the Committee on Electrical Insulation is an example of one mode of operation of the National Research Council. Beginning as a small committee of the Division of Engineering and Indus-

trial Research about nine years ago, this committee has arranged each year for a symposium on the results of current investigations on dielectrics. At these symposia some 15 or 20 papers are ordinarily offered for discussion, and of late years the meetings of the committee, held in various industrial centers in the northeastern states, often in conjunction with other meetings of electrical engineers, have attracted large attendance. The meeting of last fall was held at Pittsfield, Mass., under the host auspices of the General Electric Company. Reports of these meetings are manifolded inexpensively and are circulated among electrical engineers both in the United States and to a considerable extent abroad.

The committee now contains an active group of about ninety members and an even larger number of additional correspondents. It has become an effective agency for the encouragement of research in this field, for the exchange of information on current developments and for the stimulation of new research on matters brought out in discussion at its annual conferences.

Laboratory Tours

The Division of Engineering conducted last fall the third of a series of laboratory tours designed to give industrial and financial executives an opportunity to see the relationship of research to industry as carried out in certain industrial laboratories. The institutions visited last fall were: General Electric Company, Schenectady, N. Y.; Eastman Kodak Company, Rochester, N. Y.; B. F. Goodrich Company, Akron, Ohio; Gulf Refining Company, Pittsburgh, Pa.; Mellon Institute, Pittsburgh, Pa.; Bell Telephone Laboratories, New York City.

The division has also lent its assistance this summer to the American Committee for the Third World Power Conference in the organization of similar tours offered to the members of the conference when it convened in Washington early in September.

Highway Research Board

The Highway Research Board represents a method by which the Research Council offers continuing assistance to the Federal Government in effecting coordination of non-governmental research agencies, such as the state highway commissions, engineering departments in universities and a number of industrial corporations which are concerned with aspects of the planning, building and maintenance of highways during this period when motor transport is dominant. The board now has contacts with all the state highway agencies and with some thirty-five technical and commercial associations and organizations of national scope. Its numerous committees represent problems of highway finance, transportation economics, design, materials and construction, maintenance, traffic flow and regulation, safety, and soils investigations from the point of view of the highway engineer and administrator.

The fifteenth meeting of the Highway Research Board was held in Washington on December 5 and 6 with an attendance of over 350 for the presentation and discussion of a large number of reports prepared under the auspices of committees of the board. In addition to the publication of the *Proceedings* of these annual meetings, the board also issues a monthly abstract leaflet, which gives advance information on important research in progress in this field, and digests of articles published in various journals which ought to be made widely available.

Sex Research

One of the most important projects undertaken by the National Research Council in the field of the medical sciences is the program which the Committee for Research in Problems of Sex has been conducting for over fourteen years and which has been supported by appropriations from the Rockefeller Foundation.

During the early years of these investigations studies in the physiology of reproduction with special reference to the sex hormones were emphasized. Of recent years increasing attention has been given to the psychology and psychobiology of sex. Altogether, over 760 papers have resulted from this work at the hands of some 66 collaborators in many institutions of the United States. During the past year the committee has had at its disposal a sum of $77,000, from which $72,050 was allotted in grants for eighteen projects located at sixteen institutions.

Early last January a conference of the committee and several of its collaborators was held in St. Louis to plan for the revision of the book entitled "Sex and Internal Secretions," edited under the auspices of the committee in 1932 by Dr. Edgar Allen, of the Yale University Medical School. A revised edition of this book is to be published later this year.

A valuable result obtained through this undertaking has been the development of independent centers for research in this field.

Narcotics Research

The Council's Committee on Drug Addiction has been engaged for the past seven years in a study of the chemistry of narcotic alkaloids and the physiological reactions of these substances for the purpose of obtaining precise knowledge upon the composition of these drugs and their effects in medical practice and in addiction cases. A strong laboratory has been created at the University of Virginia for analytical and synthetic studies of this group of chemicals. An-

other strong group has been built up at the University of Michigan for pharmaceutical studies of substances produced by this chemical laboratory. Up to this time about 300 new alkaloids have been prepared, the more promising of which have been fully tested physiologically with interesting and useful results in regard to several of the new substances as leading possibly to the production of more controllable and more beneficial drugs than opium and its derivatives. Several of these substances have been or are being patented and presented to the United States Government in the person of the Secretary of the Treasury.

All the clinical work in connection with the study is being carried out by the United States Public Health Service Division of Mental Hygiene at the New Narcotic Farm at Lexington, Ky., and at the State Hospitals of Massachusetts under the direction of the Department of Public Health.

The committee has been greatly aided in studying the underlying principles of narcotic drugs in relation to drug addiction by other universities and departments of the Federal Government and by several large manufacturing firms.

The comprehensive book prepared by Dr. Small and published by the Public Health Service forms a base line for all studies in this field, and permission has been granted for its translation into three foreign languages.

Medical Reports

The Division of Medical Sciences has sponsored the production of two significant reports which have been issued during the past year. One of these was a survey of research in progress in this country and abroad on the gonococcus and gonococcal infections. This study was undertaken in cooperation with the American Social Hygiene Association. The second report was a survey of the relative incidence of tropical diseases. This was published by the *American Journal of Tropical Medicine* in a volume entitled "A Geography of Disease."

Radiation Research

The Committee on Radiation, which is encouraging research upon the biological effects of ultra-violet light, x-rays and radium emanations, has supported a coordinated program of research in this field during the past seven years by grants of considerable funds contributed by certain foundations to collaborators now numbering about fifty. The committee has thus had a part in the introduction and adaptation for biological research of the new techniques of physics which have opened up large new areas for investigation, particularly with respect to genetics.

Last spring a two-volume treatise was published entitled "The Biological Effects of Radiation," which had been prepared under auspices of this committee, to present a comprehensive review of present knowledge of this subject.

Child Development

This year marks the transition to independent status of the program for the encouragement of research in child development which the Research Council has carried on for several years supported by funds provided by the Laura Spelman Rockefeller Memorial and later by the General Education Board. The systematic development of this field was begun by the Council by the appointment in 1920 of a Committee on Child Development. Between 1925 and 1933, four conferences were held for the discussion of the organization and course of research in this field. A full time director for the committee was maintained between the years 1926 and 1929; and in order to aid in the development of trained research personnel a series of post-graduate scholarships (under which 116 appointments were made) and a series of post-doctoral fellowships (under which 14 appointments were made) were maintained for several years. An abstract journal in this field, *Child Development Abstracts,* was established and is now in its tenth volume. Numerous research projects have been encouraged by the committee. Interest in this field developed rapidly, and at a conference held in Chicago on June 24, 1933, the committee brought about the organization of a Society for Research in Child Development. This society now has a membership of over 300 and has recently taken over most of the responsibilities of the Council's former committee.

The whole enterprise, through a preliminary phase of about five years and a more active later phase of ten years, is an example of the successful development of a new movement in science through stimulation of interest in an important subject and the coordination of support among workers in the field, until eventually a stage has been reached at which the movement can proceed on a self-supporting basis.

State Archeological Surveys

A similar movement is also in progress with respect to the career of the Council's Committee on State Archeological Surveys, leading to the establishment in December, 1934, of a Society for American Archeology which will be able in various ways to extend the purposes which the committee has had in view. As one of its first activities the society has undertaken the publication of a quarterly journal, *American Antiquity,* the first number of which was issued in July, 1935.

The Committee on State Archeological Surveys has endeavored to encourage and coordinate research in

American archeology, particularly in the Mississippi Valley and the Southeastern states. A number of conferences have been held by the committee for the correlation and interpretation of current findings and to promote a realization for the need of careful and well-advised exploratory field work. A series of informational bulletins has been issued from the office of the chairman of the committee. The committee has also been instrumental in arranging for the administration of government relief funds from the Works Progress Administration and the Tennessee Valley Authority for work in the Tennessee Valley for the recovery of archeological remains in regions soon to be inundated by dams now under construction or projected.

A large number of other undertakings of the Council might be added to this account, but it is not intended in this place to give a statement of all the activities of the Council during the past year. The full report will be published with the Annual Report of the National Academy of Sciences in April, 1937.

Grateful acknowledgment should be made in this place to the Carnegie Corporation and the Rockefeller Foundation for their aid in tiding the administration of the Council over a period of reduced income, in addition to their other large contributions.

SCIENTIFIC EVENTS

THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ACCORDING to Science Service, the International Union of Geodesy and Geophysics is now meeting in Edinburgh, with representatives from thirty-five countries in attendance. Some thirty-five Americans are present, representing governmental bureaus, colleges and research institutions. Dr. William Bowie, chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, is president of the conference.

The fields of geodesy, seismology, terrestrial magnetism and electricity, physical oceanography, volcanology, meteorology and scientific hydrology are covered by seven associations of which the International Union of Geodesy and Geophysics is composed.

A few of the subjects to be discussed are: The aurora, the transmission of radio signals, the determination of the figure of the earth, isostasy, the Wegener theory of drifting continents, the variation of latitude, the prediction of weather, the variation of the compass, the making of a world magnetic map to aid navigation by water and air, the location of epicenters of earthquakes and the determination of the times of travel of earthquake waves, the determination of the configuration of ocean basins, the cause of volcanoes both on continents and on islands, the evaporation of water from land and lakes and the growth or retreat of glaciers.

Besides Dr. Bowie, the following representatives of the U. S. Government are delegates: Captain N. H. Heck and Walter D. Lambert, of the U. S. Coast and Geodetic Survey; Dr. Paul R. Heyl, of the National Bureau of Standards; Dr. Oscar E. Meinzer, of the U. S. Geological Survey; R. Hanson Weightman, of the U. S. Weather Bureau; Dr. Oliver R. Wulf, of the U. S. Bureau of Chemistry and Soils; Lieutenant P. W. Thompson, of the U. S. Army.

The Carnegie Institution of Washington is represented by Dr. Arthur L. Day, Dr. John A. Fleming, Lloyd V. Berkner, Harry D. Harradon and William J. Peters.

Other Americans expected include: Professor Harry Bateman, of the California Institute of Technology; Dr. James E. Church, University of Nevada; Professor Richard M. Field, Princeton University; Frank Goldstone, Shell Petroleum Corporation; Dr. Laurence M. Gould, Carleton College; Professor Beno Gutenberg, California Institute of Technology; Dr. William H. Hobbs, University of Michigan; Columbus Iselin, Woods Hole Oceanographic Institution; the Rev. J. Joseph Lynch, Fordham University; the Rev. James B. Macelwane, St. Louis University; Professor Edwin G. Conklin, Princeton University; Carl Elges, Nevada Agricultural Experiment Station; Roger Revelle, Scripps Institution of Oceanography; Dr. Carl G. Rossby, Massachusetts Institute of Technology; Dr. Harlan T. Stetson, Harvard University; Dr. William T. Thom, Jr., Princeton University; Professors Thomas G. Thompson and Clinton L. Utterback, University of Washington; Dr. T. Wayland Vaughan, Scripps Institution of Oceanography.

THE PITTSBURGH MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

THE autumn meeting of the American Society of Civil Engineers will be held in Pittsburgh, Pa., from October 13 to 17. The New England and New York State floods of 1936, as well as those of the Ohio River and its tributaries, their health and sanitation aspects and the problems of flood control in general, will be one of the chief topics on the program.

At the opening session of the technical meetings, on Tuesday morning, James J. Davis, United States Senator from Pennsylvania, will present a paper on "The Flood of 1936 in the Pittsburgh Region." In an afternoon session, the same day, "The Health and Sanitation Aspects of the 1936 Flood" will be discussed

jointly by Abel Wolman, chief engineer of the State Department of Health, Maryland, and Professor Thorndike Saville, dean of the College of Engineering, New York University. They will be followed by a paper on "The Economic Aspects of Flood Control," by Nathan B. Jacobs, president, Morris Knowles, Inc., Pittsburgh.

The first paper to be presented in the Symposium on Flood Control on Wednesday morning will be a discussion of "The New England Floods of 1936," by W. F. Uhl, hydraulic engineer, Chas. T. Main, Inc., Boston, Mass. This will be followed by an examination of the reports of the "New York State Floods of 1936," by A. W. Harrington, district engineer of the U. S. Geological Survey at Albany, N. Y.

Further discussion of the "1936 Flood in the Upper Ohio and Tributaries" will be presented on Wednesday afternoon by E. K. Morse, engineer member, Water and Power Resources Board of Pennsylvania, and Professor Harold A. Thomas, department of civil engineering at the Carnegie Institute of Technology. This will be followed by an address by Lieutenant-Colonel W. E. R. Covell, Corps of Engineers, U. S. A., U. S. district engineer, Pittsburgh, in which he will discuss "Federal Plans for Flood Control." The session then will be thrown open for general discussion of flood problems and methods for flood control.

Other symposiums on the civil engineers' program include "Economic Aspects of Energy Generation"; "Structural Application of Steel and Light Weight Alloys"; "The State System of Plane Coordinates"; "Volume of Traffic and Financial Problems Involved in the Planning of Major Highways"; "Stream Pollution," and "Modern Highway Design and Construction."

It is expected that attendance at the meeting, one of the most extensive in technical discussions in the history of the society, will exceed 1,200. Included in the list of speakers will be civil engineers of prominence from Albany, N. Y.; Baltimore, Md.; Boston, Mass.; Charleston, W. Va.; Cincinnati, Cleveland, Columbus and Massillon, Ohio; Denver, Colo.; Fairmont, W. Va.; Madison, Wis.; Midland, Mich.; New York, N. Y.; Pittsburgh, Pa.; Princeton, N. J., and Washington, D. C.

The American Society of Civil Engineers, of which Dr. Daniel W. Mead, professor emeritus of hydraulic and sanitary engineering of the University of Wisconsin, is president, is the oldest national body of its kind in the United States. Founded in 1852, its present membership of more than 15,000 is divided geographically into 58 local sections, which include all states and possessions. In addition, there are 114 student chapters in engineering colleges throughout the country.

THE SUMMER MEETING OF THE AMERICAN MATHEMATICAL SOCIETY

THE forty-second summer meeting of the American Mathematical Society and the nineteenth colloquium were held at Harvard University, Cambridge, Massachusetts, in connection with the Harvard Tercentenary Conference of Arts and Sciences, from Monday, August 31, to Saturday, September 5. Harvard University, celebrating its Tercentenary, was a gracious host, and hospitality was unbounded. All lectures given during the week under the auspices of the Tercentenary Committee were open to the mathematicians. More than half of those attending were housed without charge in the Yard. All the facilities of the university were at the disposal of the visitors, who were unanimous in praise of the arrangements made for their comfort and convenience.

The Mathematical Association of America, the Institute of Mathematical Statistics, the Association for Symbolic Logic and the American Astronomical Society held sessions during the same week. One thousand persons attended the mathematical meetings, of whom 443 were members of the society.

One of the chief features of the meeting was the series of Harvard Tercentenary Conference Lectures delivered by eminent mathematicians, both foreign and American, whom Harvard University invited as lecturers. These lectures were all broadcast on both long and short wave, and will be published in the journals of the society or elsewhere. Following is a list of the titles:

I. "Uncertain Inference": Ronald Aylmer Fisher, Sc.D., professor of eugenics, University of London.

II. "The Indian Mathematician, Ramanujan": Godfrey Harold Hardy, D.Sc., LL.D., D.Phil., professor of mathematics, University of Cambridge.

III. "Truth in Mathematics and Logic": Rudolf Carnap, D.Phil., professor of philosophy, Deutsche Universität, Prague.

IV. "L'extension du calcul tensoriel aux géométries non-affines": Élie Joseph Cartan, D.Sc., professor of mathematics, University of Paris.

V. "Waring's Problem and Its Generalizations": Leonard Eugene Dickson, Ph.D., professor of mathematics, University of Chicago.

VI. "The Mathematical Work of Ramanujan": Godfrey Harold Hardy, D.Sc., LL.D., D.Phil., professor of mathematics, University of Cambridge.

VII. "The Relativistic Problem of Several Bodies": Tullio Levi-Civita, D.Math., D.Sc., professor of rational mechanics, University of Rome.

VIII. "Astronomical Consequences of the Relativistic Two-body Problem": Tullio Levi-Civita,

D.Math., D.Sc., professor of rational mechanics, University of Rome.

IX. "The Cosmical Constant and the Recession of the Nebulae": Sir Arthur Stanley Eddington, Sc.D., LL.D., professor of astronomy, University of Cambridge.

A series of four colloquium lectures entitled "Topics in General Analysis" were delivered by Professor E. W. Chittenden, of the University of Iowa. The series will appear in book-form. By invitation of the Committee on Program, Professor G. C. Evans, of the University of California, gave on Saturday morning an address of one hour's duration entitled "Methods of Modern Analysis in Potential Theory." Besides these extended lectures there were nine sessions of the society at which short papers numbering 118 were presented.

The joint dinner of the mathematicians at the Copley Plaza was attended by 520 people. Professor and Mrs. Harlow Shapley entertained the visiting mathematicians and astronomers at a garden party on Thursday afternoon at the Harvard Observatory. There were numerous excursions to points of interest in Boston and the neighboring country.

It was announced at the meeting that the invitation extended by the American Mathematical Society to the International Congress of Mathematicians to hold the 1940 International Congress in America had been accepted.

R. G. D. RICHARDSON,
Secretary

THE DEBT OF INDUSTRY TO THE UNIVERSITIES

ON the occasion of the Harvard Tercentenary celebration six industrial leaders addressed a letter to President Conant which reads as follows:

The coming 300th anniversary of the founding of Harvard College is an appropriate occasion for calling public attention to the indebtedness of American industry to the universities.

In the Tercentenary about to be celebrated Harvard is commemorating not only its own birth but the founding of higher education in this country. For this reason it seems fitting that some of us who are engaged in industry should take this opportunity to send our greetings to Harvard as the first of a now large family of centers of learning in this country and at the same time to acknowledge the vital importance of university education to industrial progress.

The large and increasing number of university-trained men in industry and business gives ample evidence of the great influence that university education has had on industrial progress. In addition, a different sort of contribution has been made that in promise and initial achievement seems to be of almost revolutionary importance.

Scientific research is still young, even in the life of the universities, which are primarily responsible for its existence. Having caught the spirit of research from the universities, industries have applied its methods to their own affairs—in many cases with amazing results. The last quarter century has seen the number of industrial research laboratories in this country grow from a mere handful to more than 1,500 and the number is rapidly increasing.

Without the evolution of research in the universities, these industrial laboratories might never have come into existence. Besides the very idea of research the universities have furnished industry with men possessing knowledge not only of the underlying scientific facts and theories but of the methods and techniques of research. From the universities also flows much of the basic knowledge of science on which modern technical industry has built and will build in the future.

It seems fitting at this time, therefore, that we who are engaged in the management of industry, in recognition of our indebtedness to the group of institutions which you represent, should send to you as president of Harvard University our greetings and our congratulations.

In doing so we hope to stress—what may not have been widely enough recognized—that our industrial progress, and hence much of our national well-being, has many of its roots in, and derives much of its nourishment from, the institutions of which yours is the senior representative.

This letter is signed by Walter S. Gifford, president of the American Telephone and Telegraph Company; Alfred P. Sloan, Jr., president of the General Motors Corporation; Thomas G. Watson, president of the International Business Machines Corporation; Pierre S. du Pont, chairman of the board of E. I. du Pont de Nemours and Company; Owen D. Young, chairman of the board of the General Electric Company, and Walter C. Teagle, president of the Standard Oil Company of New Jersey.

DEGREES CONFERRED AT THE HARVARD TERCENTENARY CELEBRATION

AT the Harvard Tercentenary exercises on September 18 sixty-two degrees were conferred on those who took part in the Tercentenary conferences. These included twenty-three doctorates of letters, two doctorates of law, one doctorate of music, two doctorates of divinity and thirty-four doctorates of science. In conferring the degrees in science, President Conant read citations as follows:

EDGAR DOUGLAS ADRIAN—A physiologist whose brilliant experimentation established new principles concerning nerve impulses and the action of sense organs.

EDWARD BATTERSBY BAILEY—A British geologist whose

skillful questioning of the Scottish Highlands drew forth revealing answers, telling of the origin of mountain ranges and their evolution in the past.

SIR JOSEPH BARCROFT—An investigator of many phases of the respiration of higher animals; a beloved guide to younger men on both sides of the Atlantic.

FRIEDRICH BERGIUS—A modern magician; his knowing touch transforms coal to oil.

NORMAN LEVI BOWEN—A scientific Vulcan, in his laboratory furnaces he measures those forces which once formed our igneous rocks.

RUDOLF CARNAP—A philosopher of penetrating insight, who lights the way for those who seek through logic the unity of the world.

ÉLIE JOSEPH CARTAN—A versatile investigator in the realm of pure thought; a mathematician who has advanced his science on many fronts.

JAMES BERTRAM COLLIP—A skillful biochemist; a bold explorer among the tangled complexities of the internal secretions.

ARTHUR HOLLY COMPTON—A physicist who forces light itself to illumine the dark secrets of its still mysterious nature.

PETER DEBYE—A large-hearted physicist who gladly lends the chemist a helping hand by elucidating the electrical properties of matter.

LEONARD EUGENE DICKSON—A fruitful speculator on the significance of numbers; an algebraist noted for his stimulating work.

SIR ARTHUR STANLEY EDDINGTON—A student of the cosmos who peers within the atom and surveys the expanding universe, an expounder to the multitude of the poetry of modern science.

HANS FISCHER—A master builder of molecular structure whose labors tell us why grass is green and blood is red.

RONALD AYLMER FISHER—A student of heredity who has improved statistical methods and assisted agriculture by the application of his science.

CORRADO GINI—A versatile sociologist and statistician who early turned his attention to that most vital problem, the growth of populations.

GODFREY HAROLD HARDY—A British mathematician who has led the advance to heights deemed inaccessible by previous generations.

ROSS GRANVILLE HARRISON—An embryologist whose method of transplantations yields new insight into the process of development.

JOHAN HJORT—The naturalist of the northern sea, whose studies and explorations have benefitted alike the science of biology and the fisheries of his native land.

SIR FREDERICK GOWLAND HOPKINS—From John Harvard's university, the discoverer of the vitamins, a pioneer in many fields, whose work stands as a symbol of the ceaseless adventure of the human mind.

BERNARDO ALBERTO HOUSSAY—A physiologist noted for his studies of the ductless glands, a leader of science in the New World to the south.

PIERRE MARIE FELIX JANET—A pioneer in studying the multifarious phenomena of mental pathology; his systematic analysis founded a branch of psychology.

CHARLES GUSTAV JUNG—A philosopher who has examined the unconscious mind, a mental physician whose wisdom and understanding have brought relief to many in distress.

SCHACK AUGUST STEENBERG KROGH—A physiologist forever probing with new instruments the unknown mechanism of life processes.

KARL LANDSTEINER—The master of the science of immunology, the discoverer of those fundamental principles which made blood transfusion possible, saving countless lives.

ANDREW COWPER LAWSON—A geologist who has ranged widely both in time and space.

TULLIO LEVI-CIVITA—A mathematician great in his accomplishment, an intellectual leader of the land we all revere, the birthplace of the art and science of the present day.

BRONISLAW MALINOWSKI—An anthropological explorer who initiated a new movement for the study of the gregarious habits of the human race.

JOHN HOWARD NORTHROP—A chemist turned biologist, a skilled manipulator of those catalysts on which life depends.

ANTONIE PANNEKOEK—An astronomer who has gauged the distances of the dark nebulae; an astrophysicist who has assayed the stellar atmospheres.

LEOPOLD RUZICKA—A chemist, daring in his attack, brilliant in his methods, successful in his interpretations of architecture of nature's baffling compounds.

KOYOSHI SHIGA—The discoverer of the cause of epidemic dysentery, a valiant and effective fighter in the international struggle for prevention of disease.

FILIPPO SILVESTRI—A brilliant entomologist who has searched many continents to find those parasites which guard our crops.

HANS SPEMANN—A biologist who experimented with embryonic tissue and discovered a new approach to those agents which determine organic form.

THE SVEDBERG—A man who sees beyond the microscope, at his bidding centrifugal forces make giant molecules reveal their size.

RECENT DEATHS

DEAN HENRY LANDES, for forty-one years professor of geology at the University of Washington and state geologist from 1901 to 1921, died on August 23 in his sixty-ninth year.

DR. JOHN H. MCNEIL, chief of the Bureau of Animal Industry of the New Jersey Department of Agriculture, died on September 18 at the age of sixty-six years.

DR. ALEXANDER ANDERSON, lately president of University College, Galway, for many years professor of natural philosophy in the college, died on September 5 at the age of seventy-eight years.

HENRI LOUIS LE CHATELIER, formerly professor of chemistry at the Ecole des Mines, Paris, and of min-

eralogical chemistry at the Collège de France, distinguished for his work on the combustion of gaseous metal and chemical mixtures, died on September 18. He was eighty-six years old.

DR. JEAN CHARCOT; Professor de Vaux, French physicist; Dr. Larronde, secretary general of the French Geographical Society, and Professors Parat and Jacquir, of the Sorbonne, lost their lives when the French Polar exploration ship, the *Pourquoi Pas,* foundered in Faxa Fjord, Iceland, on September 16. The expedition, sponsored by the Paris Trocadero Museum of Ethnography, sailed from Copenhagen on April 25. There was only one survivor of the forty men comprising the expedition.

SCIENTIFIC NOTES AND NEWS

SIR FREDERICK GOWLAND HOPKINS, professor of biochemistry at the University of Cambridge, will deliver the Edward K. Dunham Lectures for the promotion of the medical sciences of the faculty of medicine at Harvard University. The general subject will be "The Significance of Catalysis in Biology." On October 6 he will speak on "The Catalytic Equipment of Micro-organisms" and on October 8 on "The Nature of Biocatalytic Systems in General." The lectures will be given at 5 o'clock at the Harvard Medical School.

SIR JOSEPH BARCROFT, professor of physiology at the University of Cambridge, will deliver the Terry Lectures at Yale University on October 5, 6 and 7. Sir Joseph will speak on "Three Aspects of the Relation of Environment to the Organism." The lectures will be given in Strathcona Hall at 4:30 P.M. The topics of the individual lectures are: "Mental Efficiency Considered in Relation to some Properties of the Blood"; "The Origins of Behavior in the Foetal Environment"; and "The Transition from Foetal to Neo-natal Conditions." Sir Joseph gave the opening lecture of the year on September 24 before the Cleveland Academy of Medicine, where he spoke on "The Genesis of Respiration."

AT the meeting of the American Astronomical Society held at Cambridge, Mass., from September 2 to 5, Hisashi Kimura, director of the International Latitude Observatory at Mizusawa, Japan, known especially for his studies of the variation of latitude, was elected to honorary membership. The following new members of the council were elected: R. S. Dugan, Princeton, *vice-president;* J. C. Duncan, Wellesley, *secretary;* F. C. Jordan, Allegheny, *treasurer;* D. B. McLaughlin, Michigan, S. L. Boothroyd, Cornell, and Keivin Burns, Allegheny, *councilors.* Otto Struve, Yerkes, was elected to membership on the U. S. National Committee of the International Astronomical Union for the term 1937–40.

N. S. OSBORNE, physicist of the National Bureau of Standards, received an honorary degree of doctor of engineering at the exercises on the occasion of the recent installation of Dr. Grover C. Dillman as president of the Michigan College of Mining and Technology.

THE gold medal of the Royal College of Surgeons has been awarded to Dr. James Alexander Murray, in appreciation of his services as director of the laboratories of the Imperial Cancer Research Fund.

IN the issue of SCIENCE for July 31 it was reported that one of the Field Medals at the International Congress of Mathematicians was awarded to Professor K. A. M. Ahlfors. A correspondent writes: "This medal was awarded not to Professor Ahlfors, but to his son (I believe), Lars V. Ahlfors, adjunct professor of mathematics in the University of Helsingfors. L. V. Ahlfors was lecturer in mathematics at Harvard University during 1935–36 and is now beginning a faculty appointment as assistant professor of mathematics at that institution."

DR. JOHN H. WOLFENDEN, lecturer in physical chemistry at Exeter College, University of Oxford, is Frank B. Weeks visiting professor of chemistry at Wesleyan University for the first half of the first semester of the present academic year.

LEE ROY SCHOENMANN has been appointed Charles Lathrop Pack professor of wild land utilization in the School of Forestry and Conservation of the University of Michigan.

DR. GLENN L. JENKINS, professor of pharmaceutical chemistry at the University of Maryland, has been appointed head of the department of pharmaceutical chemistry in the College of Pharmacy of the University of Minnesota.

HARRY T. POWER, for a number of years chief petroleum engineer for the Gulf Oil Corporation of Oklahoma, formerly a staff member of the U. S. Bureau of Mines, has been appointed professor of petroleum engineering and chairman of the department at the University of Texas.

DR. CARL P. RUSSELL, of California, formerly chief of the Museum Division of the National Park Service, has been appointed chief of the Wildlife Division to succeed the late George M. Wright, who was killed in an automobile accident last February.

AT the Massachusetts State College Arthur P. French has been promoted from assistant professor to professor of pomology and plant breeding and Rich-

ard C. Foley from instructor in animal husbandry to assistant professor. Alfred A. Brown has been appointed assistant research professor of agricultural economics.

A. GEORGE STERN, who was recently consulting chemist with the A. R. Maas Laboratories at Los Angeles, Calif., has joined the U. S. Bureau of Mines, Washington, D. C., as assistant to A. C. Fieldner, chief engineer of the Experiment Stations Division.

THE *Journal* of the American Medical Association reports that the Texas State Department of Health has financed through social security funds a division of industrial hygiene, with Dr. Carl A. Nau, formerly professor of physiology at the School of Medicine of the University of Oklahoma, as director. Preliminary surveys are now in progress of potential health hazards in industry, which will be studied in detail in the laboratory now being equipped.

PROMOTIONS of staff members of the Scripps Institution of Oceanography of the University of California at La Jolla, taking effect on July 1, include: Dr. Richard H. Fleming, from research associate to instructor in oceanography; Dr. Denis L. Fox, instructor to assistant professor of physiology of marine organisms; Dr. Claude E. ZoBell, from instructor to assistant professor of marine microbiology, in charge of the Biological Program; Dr. Roger Revelle from research associate to instructor in oceanography, on leave from September, 1936, to June, 1937.

DR. RICHARD H. MCCOY has joined the staff of the Wistar Institute and will devote his time to problems in biochemistry with special reference to nutrition. During the past year he has been a Rockefeller fellow working with Dr. McLean in the department of physiology of the University of Chicago, in a study of the relation of the parathyroid gland to the formation and destruction of bone.

DR. THOMAS C. POULTER, formerly head of the departments of chemistry and physics and the division of physical sciences, mathematics and astronomy at Iowa Wesleyan College, has been appointed director of the Research Foundation of the Armour Institute of Technology. Dr. Robert D. Snow, recently director of research for the Phillips Petroleum Company, will direct a project for a study of the coals of Indiana. The Research Foundation of the institute was founded in April for the purpose of promoting research in affiliation with Armour Institute of Technology.

DR. WILLIBALD SCHOLZ, professor of neurology and psychiatry at Munich, has become director of the department of cerebral pathology of the German Research Institute of Psychiatry, Kaiser Wilhelm Institute, Munich. He succeeds the late Professor Walther Spielmeyer.

THE Commonwealth Council of Scientific and Industrial Research of Australia, according to *The Christian Science Monitor,* has appointed F. N. Ratcliffe to study the problem of soil drift in southwest Queensland. The Commonwealth Council of Scientific and Industrial Research is subsidized by the government and the question of soil erosion has been considered to be sufficiently serious to warrant immediate attention.

PROFESSOR E. O. ESSIG, of the division of entomology of the University of California, will spend a year in Europe studying aphids, under a grant of the C. R. B. Educational Foundation of New York.

BORIS A. KRUKOFF, of the New York Botanical Garden, sailed recently for Brazil, where he will continue his work on the poisonous plants of the Amazon territory.

DR. BAILEY WILLIS, professor emeritus in geology at Stanford University, is *en route* from California to Java with a view to continuing his studies in comparative seismology as research associate of the Carnegie Institution of Washington. Studies of the dynamic, geologic conditions in the arcuate islands of the Orient were begun in 1927, but were put aside for the investigation of the rift valleys of East Africa in 1929. The results of that expedition having now been published by the Carnegie Institution in a monograph entitled "African Plateaus and Rift Valleys," Dr. Willis returns to the problem of the structural and dynamical conditions to which the island chains of the Philippines and Dutch East Indies owe their existence. He expects to be absent for six months or a year.

DR. E. M. K. GEILING, chairman of the department of pharmacology of the University of Chicago, has returned from his third trip to Rose Harbor, northwest of Vancouver, to secure pituitary glands of the whales. He was accompanied by Dr. Robert Walmsley, of the department of anatomy of the University of Edinburgh, fellow of the Rockefeller Foundation, who is studying the vascular system, and Lewis L. Robbins, research assistant. Dr. Geiling returned by way of the Atlantic, going to Tadoussac, 200 miles north of Quebec at the junction of the St. Lawrence and Saginaw Rivers, to investigate possibilities there.

ARRANGEMENTS for further archeological investigations at Tepe Gawra, in northern Mesopotamia, where the world's oldest town was uncovered last year, have been completed by the American School of Oriental Research in Baghdad and the University Museum of the University of Pennsylvania. The expedition,

sponsored jointly by the two institutions, will be directed by Dr. Ephraim A. Speiser, director of the American School of Oriental Research in Baghdad and professor of Semitics at the University of Pennsylvania, who will carry on field work. This is his third season in Mesopotamia. Dr. Speiser sailed for the Near East on September 15, and expects to begin work at Tepe Gawra early in October. Assisting him on the scientific staff will be E. Bartow Muller, architect; Arthur J. Tobler, recorder, and Alfred Bendiner, artist, all of the University of Pennsylvania.

THE London *Times* states that at the general meeting of the British Association for the Advancement of Science the British Science Guild was incorporated with the association. The formation of the guild in 1905, with Lord Haldane as first president, was primarily due to Sir Norman Lockyer. Its aim, which coincides with the policy of the association to lay emphasis on the social implications of science, was to influence public opinion, and to promote closer contact between science on the one hand and social problems and public affairs on the other. The annual lectures associated with the name of Norman Lockyer will be continued by the association. The past work of the guild has been varied, comprising reports on agricultural research, patent law, river pollution, the conservation of national energy resources, etc.

THE residuary estate of the late Mary Gardiner Thompson, who died last April, is left to Columbia University, the Presbyterian and New York Hospitals, the New York Historical Society, the Children's Aid Society and the New York Association for Improving the Condition of the Poor. Each of these institutions receives the sum of $2,201,491.

IN giving his report on the three hundredth anniversary fund of Harvard University, President Conant said that the friends and alumni who have contributed to the fund number 8,881; that they had subscribed $760,954 without restriction, $523,696 specifically for the support of university professorships, $997,685 specifically for the endowment of Harvard national scholarships and $492,636 specifically for the encouragement of work in the physical sciences, a grand total of $2,774,972. He recorded three other gifts. First was that of Lucius N. Littauer, already announced but not yet formally reported, of $2,000,000 for the support of instruction and research in public administration. The second came from the Carnegie Corporation in recognition of the tercentenary and in the interest of dental research and dental education. This was $350,000. Third was a gift of $250,000 received from Mrs. Frances Glessner Lee to establish "The George Burgess Magrath Endowment for Legal Medicine." These and a few minor benefactions made a total of $5,448,192.

PUBLIC institutions will ultimately receive most of the estate of George Blagden, formerly a broker and vice-president of St. Luke's Hospital, New York City, who died in 1934. The estate was valued at $2,510,729 gross and $2,337,118 net, consisting principally of securities. Five institutions will receive cash bequests amounting to $87,500. Upon the death of named beneficiaries, the residuary estate will go to Harvard University and to St. Luke's Hospital, New York City, in equal shares. Bequests made in addition to the residuary estate were: The New York Association for Improving the Condition of the Poor, of which Mr. Blagden was treasurer, $25,000; St. Luke's Hospital, $42,500; Grace Church, $10,000; The National Society for the Prevention of Blindness and the Board of Visitors of the New York State Orthopedic Hospital for Children, $5,000 each.

DISCUSSION

SIGNIFICANT FIGURES IN STATISTICAL CONSTANTS

STATISTICIANS might well follow the lead of the physicists and engineers who, in general, have consistent rules for the retention of significant figures. Statisticians have devised formulae for estimating the standard error and probable error of statistical constants, but no uniformity of practice exists in the retention of significant figures. Not only is much time wasted on computations, due to the retention of more figures than the precision of the data warrants, but results expressed to many decimal places without regard to their precision give a very misleading impression of the accuracy of the results.

The analysis of a large sample in "Statistical Methods for Research Workers" (Fourth Edition, pp. 47–49) by R. A. Fisher is an example. The data, the heights of men, are given to the nearest inch, and the mean of the sample is found to be 68.6435 inches. The standard error is 0.0797 inch. Fisher concludes "from this value it is seen that our sample shows significant aberration from any population whose mean lay outside the limits 68.48 inches to 68.80 inches. It is therefore likely that the mean of the population from which our sample was drawn lay between these limits." Then why not simply find the mean of the sample to be 68.64 inches and the standard error 0.08 inch?

Grouping, which is commonly used to save labor, in itself introduces some error in the result. In the sample above, the loss in the estimation of the standard deviation is 2.28 per cent.; the loss in the estimation of the mean is half as great. This in itself would seem to be good reason not to express the constants to four decimal places.

L. H. C. Tippett in a similar example in "The Methods of Statistics" (pp. 39–41) expresses the mean of a series of 1,078 heights, given to the nearest inch, as 67.6976 inches, with a standard error of 0.082. This is followed by the startling statement that "the constants have been calculated *correct*[1] to several decimal places."

Occasionally some one suggests a rule for significant figures in statistics. Kelley[2] suggested the criterion: "Keep to the place indicated by the first figure of ½ the probable error."

Scarborough in "Numerical Mathematical Analysis" (p. 11) states that the average of 10 or more numbers which are given to n significant figures is usually true to $n+1$ significant figures. Later in the same book he states that if the probable error of the average be large, it is better to express the average to only n significant figures.

A rule generally used in physics and engineering is this[3]: "In all deviation and precision measures retain two, and only two, significant figures. . . . The place of figures corresponding to the *first* significant figure of the deviation measure is somewhat uncertain (from 1 to 9 units), while the place corresponding to the *second* significant figure in the deviation measure is uncertain by ten times this amount (10 to 99 units). Beyond this place the significance of additional figures is so slight as to be of no value."

Since the errors of measurement are ordinarily tremendously greater in biological, economic and social investigations than in physical observations, the retention of more than one doubtful figure in a constant is unjustified. Therefore when final results are published, the second doubtful figure should be dropped and the constants expressed to the figure that corresponds with the first significant figure of their respective precision measures. In all other data, and in computations, retain as many places of figures as correspond to the second place of significant figures in the pertinent deviation or precision measure. Two places of doubtful figures are thus retained so that accumulated errors due to rejections in the course of a computation may not affect the first place of uncertain figures in the result.

Many workers in the social and biological sciences are not mathematicians and use statistical analysis only as a necessary tool. For these, a definite, simple, yet mathematically sound rule is desirable. The writer suggests the following working rule: *In a final published constant retain no figures beyond the position of the first significant figure in the standard error; keep one more place in all computations.*

EDWARD B. ROESSLER
COLLEGE OF AGRICULTURE
UNIVERSITY OF CALIFORNIA, DAVIS

[1] Italics by the writer.
[2] SCIENCE, 60: 524, 1924.
[3] H. M. Goodwin, "Precision of Measurements and Graphical Methods," pp. 23–24.

PARAMECIUM MULTIMICRONUCLEATA VS. PARAMECIUM MULTIMICRONUCLEATUM

IN 1910 Powers and Mitchel[1] reported and described a new species of *Paramecium*. Powers speaks of it as a multimicronucleate type: Mitchel calls it *Paramecium multimicronucleata*. Article 14 of the International Rules of Zoological Nomenclature, speaking of specific names, states that adjectives, used as specific names, must agree grammatically with the generic name. *Multimicronucleatum* is used by Mitchel as a descriptive adjective, and since *Paramecium* is a neuter singular noun, the descriptive adjective must also have the neuter singular form.

Landis,[2] Wenrich,[3] Lieberman,[4] King,[5] Giese,[6] Diller,[7] Duodorff,[8] have followed Powers and Mitchel in using *multimicronucleata*. But Hance,[9] Lucas,[10] Stranghöner,[11] Müller,[12] Glaser,[13] Köster,[14] Frisch,[15] Jones[16] and Oliphant[17] use the grammatically correct form, *multimicronucleatum*.

Article 19 of the International Rules of Zoological Nomenclature states that "the original orthography of a name is to be preserved unless an error of transcription, a lapsus calami, or a typographical error is evident." An error of transcription and a typographical error can be ruled out. Can the mistake be called a

[1] J. H. Powers and Cl. Mitchel, *Biol. Bull.*, 19: 324–332, 1910.
[2] E. M. Landis, *Jour. Morph. and Physiol.*, 40: 111–167, 1925.
[3] D. H. Wenrich, *Trans. Amer. Micros. Soc.*, 47: 274–284, 1928.
[4] Paul R. Lieberman, *Trans. Amer. Micros. Soc.*, 48: 1–11, 1929.
[5] Robert L. King, *Jour. Morph.*, 58: 555–564, 1935.
[6] A. C. Giese, *Physiol. Zool.*, 8: 116–125, 1935.
[7] William F. Diller, *Jour. Morph.*, 59: 11–49, 1936.
[8] Michael Duodorff, *Jour. Exp. Zool.*, 72: 369–386, 1936.
[9] R. J. Hance, *Jour. Exp. Zool.*, 23: 287–333, 1917.
[10] Miriam Scott Lucas, *Proc. Soc. Exp. Biol. and Med.*, 27: 258–260, 1930.
[11] E. Stranghöner, *Arch. f. Protistenk.*, 78: 302–360, 1932.
[12] Walter Müller, *Arch. f. Protistenk.*, 78: 361–462, 1932.
[13] R. W. Glaser, *Jour. Parasitol.*, 19: 173, 1932.
[14] Willy Köster, *Arch. f. Protistenk.*, 80: 410–433, 1933.
[15] J. A. Frisch, S.J., SCIENCE, 81 (2109): 537, 1935.
[16] Edgar P. Jones, *Anat. Rec.*, 64: 108–109, 1935.
[17] Joseph F. Oliphant, *Anat. Rec.*, 64: 77, 1935.

lapsus calami? Probably not. How, then, can the change to the correct form be authorized?

JOHN A. FRISCH, S.J.

CANISIUS COLLEGE
BUFFALO, N. Y.

TROCHOSPONGILLA HORRIDA IN ARKANSAS

WE report the presence of *Trochospongilla horrida* Weltner in the East Fork of the White River near Elkins, Arkansas. The colonies collected were on the under side of stones in a shallow portion of the river where the water is scarcely flowing. The flat, branching colonies were a dirty white in color. Gemmules were present in specimens collected on July 23, 1936. The strongly spined skeletal spicules and the birotulate gemmule spicules with smooth entire margins make the identification certain.

Although reported in recent years from such far apart localities as Germany, Russia, Turkestan and China, *T. horrida* appears to have been found in the United States only four times: twice in Illinois,[1] once in Delaware[2] and the present collection in Arkansas. It appears to be the first fresh-water sponge to be reported from the state of Arkansas.

DAVID CAUSEY
HAROLD EIDSON

UNIVERSITY OF ARKANSAS

WANTED: A NEW WORD

THE word should be from the Greek because a companion word is from that language, although the late Professor Burt G. Wilder said that a mule word might be as useful as a mule animal. He quoted appendicitis in this connection.

There is a large literature relating to planktonic food for many kinds of organic life. An equally large literature should belong to benthotic food, but the awkwardness of the expression is doubtless responsible for its hiding out of literature. According to the dictionary "benthos" relates to the bottom of the sea. This is not descriptive in application for the food of many forms of aquatic life living in shallow waters—for example, that of mollusks, fishes and even young ducks which feed upon the layer of living organic matter resting upon the top layer of mud in shallow water. Among the fishes we know that hypoglossidae, catostomidae and siluridae may thrive upon this top layer of mud without depending upon larger organic prey. We all know the roundish marks on the top layer of mud made by the fishes commonly known as suckers. I could not account for long scoops made on the top layer of mud until one cloudy afternoon standing upon the railroad track near Union Springs, New York, I watched a number of bullheads feeding. They would stick the tip of the lower jaw a little way into the mud and then with a few quick movements of the caudal fin they would force themselves ahead, making the mysterious scoop markings on the mud.

At the foot of our lawn in Stamford young wild ducks know enough to feed upon the top layer of mud without being taught by parents until they are large enough to eat Nuttall's pondweed and the cracked corn which we give them.

Flounder fishermen of the Great South Bay say that mud is the only food in the stomachs of millions of flounders after they are thin from February spawning. It would be difficult for these millions of flounders to find other food. That takes me to the question if the "sideswiping" mouth of flounders is not a matter of adaptation of a species to food conditions in the course of descent.

Many years ago as a boy at New Haven I took home a fish basket of young bullheads still alive that my father said were not worth the bother of skinning. I took them to the numerous small pond holes in Beaver Meadows west of New Haven and forgot them until the meadows were filled in, when local residents collected basketfuls of well-fed bullheads as the filling in crowded them out. There was little beside the top layer of mud for them as food supply. Now I want a word for this food supply. I have asked my friends who are Greek and Latin scholars, but they have failed me after my own limitations had been reached.

ROBERT T. MORRIS, M.D.

STAMFORD, CONN.

SPECIAL ARTICLES

THE ULTRACENTRIFUGAL CONCENTRATION OF PNEUMOCOCCIC ANTIBODIES

THE ultracentrifugal analysis[1] of concentrates of the Type I pneumococcic antibodies from horse serum has shown that their proteins consist mainly of molecules with a sedimentation constant of about 16×10^{-13} cm. sec^{-1} dynes^{-1}. This, together with the presence of such molecules in the untreated antipneumococcic horse serum and their complete or almost complete absence from normal serum, is evidence that they are the real bearers of the antibody activity. Further support for this view is supplied by the observation[2] that after ultracentrifugation, most of the antibody activity appears at the bottom of the cell. The fol-

[1] Frank Smith, *Bull. Ill. St. Nat. Hist. Surv.*, 14: 11: 9–22, 1921.

[2] M. C. Old, *Trans. Amer. Micr. Soc.*, 51: 4: 239–242, 1932.

[1] J. Biscoe, F. Herčík and R. W. G. Wyckoff, SCIENCE, 83: 602, 1936; M. Heidelberger, K. O. Pedersen and A. Tiselius, *Nature*, 138: 165, 1936.

[2] M. Heidelberger, K. O. Pedersen and A. Tiselius, *op. cit.*

lowing experiments in which considerable quantities of serum and commercial antibody preparations were centrifuged in a vacuum centrifuge turning at 25,000 r.p.m. point to the same conclusion.

In these experiments two kinds of commercial Felton antibodies and an untreated antipneumococcic horse serum were centrifuged for several hours in a maximum field of ca 40,000 gravity. After stopping, the top and bottom fractions were withdrawn and subjected to the following measurements: (1) a titration of antibody content; (2) a determination of refractive index as an indication of protein content; and (3) an ultracentrifugal identification of the protein molecular species they contain. The titrations, following the method of Zozaya, Boyer and Clark,[3] were all made with the same Type I polysaccharide solution; the ultracentrifuge was of the air-turbine type recently described.[4]

Felton antibodies are now manufactured by at least two different procedures. One of these preparations (A) is made by precipitating antipneumococcic horse serum with water and dissolving in salt solution the precipitate carrying the desired activity. The other mode of manufacture (B) is more complicated, involving precipitation of the original serum with alcohol and subsequent separations at different pH's. These two concentrates did not look alike after centrifuging. Preparation (A) consisted of two layers with a sharply defined boundary. The upper two fifths (A top) was water clear and of low viscosity; the rest was a light amber-colored fluid, which became more viscous and more highly colored towards the bottom of the cell. The bottom third of this layer (A bottom) was used for analysis. Preparation (B), which was initially a stronger solution than (A), also showed two layers after centrifuging. In keeping with its higher viscosity the clear top layer (B top) had only a small relative volume (ca 5 per cent. of the whole) and the bottom-most part of the lower layer had almost the consistency of a gum. The bottom fifth of the lower layer (B bottom) served for analysis. No fraction of (B) showed any color. The bottom layers (A bottom) and (B bottom) were recentrifuged; their lower layers are designated (A bottom, 2) and (B bottom, 2). When untreated antipneumococcic horse serum (H) was centrifuged, it developed three layers: (1) a top layer (volume = ca 10 per cent.) which contained the suspended matter present in the original serum and was without antibody activity; (2) a colorless moderately viscous intermediate layer which was largely albumin (volume = ca 15 per cent.) and (3) a layer which became progressively more colored and more viscous as the bottom was approached. The bottom portion (H bottom) was a clear amber fluid.

The results obtained from these various fractions are collected in Table I. It is obvious that in solutions

TABLE I

THE APPROXIMATE CONCENTRATIONS AND DILUTIONS FOR PRECIPITIN END POINT FOR PNEUMOCOCCIC ANTIBODY CONCENTRATES

Sample	a gm/100 cc. solution	b Dilution	k = a/b
A	7.2	120	0.060
A (I+II)	8.2	120	.068
A bottom	13.4	160	.084
A bottom, 2	18.2	200	.091
B	12.8	180	.071
B (I+II)	13.4	200	.067
B bottom	17.2	240	.072
B bottom, 2	20.7	320	.065
H bottom, 2	16.4	200	.082
H	6.4	30	.213
A top	1.0	2	.500
B top	2.0	4	.500

consisting of only a pure protein antibody, the ratio of protein concentration (a) to the amount of dilution (b) needed to give a precipitin end point must be a constant (k). This is true for those fractions, especially of concentrates (B), that show only the protein with $s = 16 \times 10^{-13}$; all other fractions depart widely from constancy (column 4).

It is to be noted that the centrifugal force used was sufficient to yield an unaltered horse serum fraction with a protein content and antibody activity comparable with the commercial concentrates. The details of the ultracentrifugal analysis of these serum fractions will be published later.

Ultracentrifugal analyses of the two Felton concentrates gave results that were essentially the same. The only protein molecules to be found in the bottom layers were those with $s = 16 \times 10^{-13}$. The top fractions did not retain appreciable quantities of these molecules. Small amounts of their light molecules, which in each concentrate accounted for roughly 15 per cent. of the total protein content, were those of the principal serum globulin with $s = 7 \times 10^{-13}$; the rest, too light to sediment in a field 180,000 times gravity, were undoubtedly split products introduced by the procedures used in concentrating.

These experiments strongly support the idea that the Type I antibody is associated with the molecule having $s = 16 \times 10^{-13}$. The concentrates of antibodies against other types have molecules of the same size.[5] Since this is a molecular species that appears in appreciable quantities in horse serum only when it has become antipneumococcic, two possibilities suggest themselves. It is conceivable that during immuniza-

[3] J. Zozaya, J. Boyer and J. Clark, *Jour. Exp. Med.*, 52: 471, 1930.

[4] J. Biscoe, E. G. Pickels and R. W. G. Wyckoff, *Jour. Exp. Med.*, 64: 39, 1936.

[5] J. Biscoe, F. Herčík and R. W. G. Wyckoff, *op. cit.*

tion this globulin is made or freed in excess in order that there may be plenty of it present to fix all the antibody activity that may develop. This could be answered by investigating the parallel development of antibodies and s(16) globulins in horses undergoing immunization; against it is the fact that the antibody concentrates here studied, coming from very different sources, have the same protein antibody ratio, *i.e.*, k of Table I is practically the same. If the alternative, that the globulin is the antibody, is true, then it is of interest to find that in a bivalent concentrate containing equal quantities of Types I and II antibodies (A, I+II and B, I+II) the protein content is not increased by the presence of the additional Type II antibodies: this indicates that a single globulin molecule can exhibit the characteristics of more than one antibody.

RALPH W. G. WYCKOFF
ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

EARTH WORMS AS TEST OBJECTS FOR DETERMINING THE VALUE OF DRUGS TO BE USED IN HUMAN INTESTINAL HELMINTH INFESTATIONS[1]

THE earthworm has for many years enjoyed the reputation of being the test object *par excellence* for determining the efficacy of "anthelmintics." In attempting to foretell the effect of any drug in man, it is necessary to make tests on lower animals with the hope of avoiding unpleasant complications. Every experimenter is, however, aware of the fact that toxicity or lethality experiments carried out in such animals can not be transferred to man with the assurance that identical effects will be produced in this species. It would seem, however, that our present state of knowledge is such as to require that we use some judgment in the choice of biological test objects. An animal without a heart would not appear to be the best object on which to study cardiac drugs, or *Macrocanthorhynchus hirudinaceus,* which has no alimentary canal, for the investigation of cathartics.

It is doubtful, however, if a more diversified group of animals was ever brought together under one heading than those designated as "worms." This is well illustrated in J. Arthur Thomson's[2] description of these animals: "It is hopeless at present to arrange with any definiteness those heterogeneous forms to which the title 'worm' is given. For this title is little more than a name for a *shape,* assumed by animals of varied nature who began to move head foremost and to acquire sides. There is no class of 'worms,' but an assemblage—a mob—not yet reduced to order."[3]

It is bad enough when we assume that an anthelmintic should act equally well on unattached roundworms, tapeworms and blood-sucking hookworms, but it would seem as if the time had come when we should give up the indiscriminate use of a biological test object of any nature as long as it looks like a worm. However, leeches, vinegar eels and above all earthworms are used by many investigators in testing "anthelmintics," but those who have chosen for this purpose test objects with other shapes, as fishes and frogs, have been ridiculed. But would not a frog, whose feet admittedly differ in shape from those of an earthworm or even a butterfly serve as well as an earthworm for determining the ascaricidal value of a group of chemical substances?

The human Ascaris is a parasitic animal living in the gut of man. It has no respiratory or circulatory system in any way related to that of an earthworm. It can live under anaerobic conditions. It is covered with a chitinous coat which is very sensitive to certain substances that have been shown to effectively kill the animal by acting on or through it. The earthworm is a free-living species inhabiting not man, but the ground. It feeds on substances in the soil rather than those of the human gut. It has no chitinous coat. It is dependent upon a circulatory system with not merely a single heart but five pairs of these organs through which circulates blood containing both corpuscles and hemoglobin. Except for its shape, there is nothing which under any consideration could be used as an excuse for taking such an animal as a test object for ascaricides, especially when one can obtain with great ease pig Ascaris, which are morphologically indistinguishable from the human Ascaris.

In spite of this, a publication has just appeared on "Rational Use of the Earthworm for the Evaluation of Vermicides."[4] No explanation is given as to why this is considered a rational use of these animals, unless it is the four pages of mathematical calculations used in comparing the "rate of change of 'apparent' speed of fatality with change in molar concentration" of three substances.

During the past year we published an article on "Methods of Testing the Anthelmintic Properties of Ascaricides."[5] Our conclusions were based on experi-

[1] The funds for carrying out this work were given by the International Health Division of the Rockefeller Foundation.

[2] J. Arthur Thomson, "Outlines of Zoology," page 10.

[3] This opinion regarding the group of "worms," the "Vermes" of Linnaeus, is not confined to recent writers alone, and some of the most modern authorities consider the grouping made by Aristotle some two thousand years ago to be superior. They speak of the so-called "phylum Vermes" as a "wastebasket," a "Rumpelkämmer" or "attic," corresponding to that place where everything that had been respected for a hundred years was piled together to save it for future use which never came.

[4] G. L. Jenkins and L. L. Manchey, *Jour. Am. Phil. Asn.*, 25: 194–201, March, 1936.

[5] P. D. Lamson and H. W. Brown, *Am. Jour. Hyg.*, 23: 85–103, January, 1936.

ments in which we tested several hundred substances on several hundred thousand pig Ascaris *in vitro,* collected the parasites passed, as well as those found at autopsy, in many hundreds of dogs infested with Ascaris, and egg-counted over 3,000 human cases of ascariasis before and after treatment.

During the course of these experiments we checked as a matter of interest, but with no intent of publication, the effect of 121 substances on both earthworms and pig Ascaris, using the *in vitro* method described in our "Methods" paper. The earthworms were tested in distilled water at room temperature, while the Ascaris were kept at 35° in saline. Of these 121 chemicals chosen from *inorganic substances, hydrocarbons, halogenated hydrocarbons, alcohols, phenols, ethers, organic acids* and their *salts, organic sulfur compounds, terpenes, sesquiterpenes, alkaloids, enzymes, glucosides, plant products, dyes, substances liberating oxygen* or *iodine,* as well as a miscellaneous group, only 6 per cent. showed a fairly close correspondence of anthelmintic action on earthworms and pig Ascaris. In 58 per cent. the Ascaris were alive after twenty hours, while the earthworms had died in from two minutes to six hours. Sixty-seven per cent. killed earthworms in thirty minutes or less, while only 8 per cent. of these substances killed Ascaris in that time.

Conclusion

(1) The use of earthworms as a test object for evaluating the activity of anthelmintics to be used in human intestinal helminth infestation is irrational.

(2) A comparative study of the lethality of 121 widely diversified chemical substances on both earthworms and pig Ascaris shows no correlation of action.

(3) *In vitro* tests of human ascaricides on pig Ascaris, which is morphologically indistinguishable from human Ascaris, are of value.

Paul D. Lamson
Charlotte B. Ward

Vanderbilt University
School of Medicine

CATALYSIS OF FORMALDEHYDE TO REDUCING SUGARS BY ASCORBIC ACID

Kusin[1] has recently shown that compounds capable of forming en-diol groups in alkaline solution (glucose, fructose, benzoin, etc.) markedly catalyze the production of reducing sugars from formaldehyde in the presence of calcium hydroxide. According to Haworth's formula ascorbic acid contains the en-diol group and, if Kusin's theory is correct, might be expected to catalyze the reaction. The writers have investigated this possibility and have found that ascorbic acid is a very active catalyst. Table 1 summarizes the results of experiments in which the rate of formation of reducing substances was followed in mixtures of formaldehyde and calcium hydroxide both with and without the addition of ascorbic acid. Ascorbic acid and excess formaldehyde were removed from the solutions before sugar estimations.

TABLE 1

Reactants	Time Minutes	Red. Subs. as glucose mg. per 100 cc
Formaldehyde + ascorbic acid + $Ca(OH)_2$	0	24.
"	30	220.
"	60	391.
"	90	312.
"	120	269.
"	180	199.
Formaldehyde + $Ca(OH)_2$	0	0.
"	60	0.
"	120	11.
"	180	154.
"	240	94.

The disappearance of formaldehyde from the solutions was about complete at the time of maximum reduction.

It will be noted that in the reaction catalyzed by ascorbic acid maximum reduction was attained before the appearance of reducing substances in the control. In both cases the curves show a maximum after which the reducing values decrease. This is possibly due to higher reducing equivalents of the smaller molecules formed early in the reaction followed by polymerization of these to larger molecules of lower reducing values.

Kusin has isolated an intermediate compound of benzoin and formaldehyde from reaction in an alkaline solution. We have obtained evidence that ascorbic acid combines with formaldehyde even in an acid solution. The suggestion has been made that simple sugars play a catalytic rôle in the photosynthetic production of carbohydrates from formaldehyde in green leaves. The evidence presented here suggests that ascorbic acid may be an active photosynthetic catalyst.

Further work is in progress and this, with experimental details, will be published elsewhere.

Edward S. West
Luman F. Ney

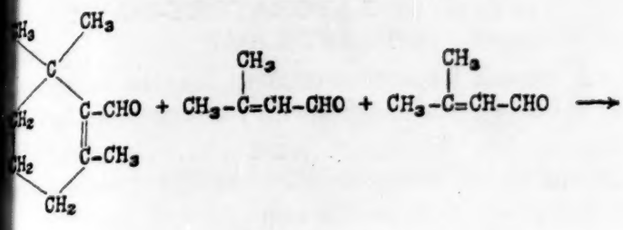
Medical School,
University of Oregon

THE CONDENSATION OF β-CYCLOCITRAL WITH DIMETHYLACROLEIN

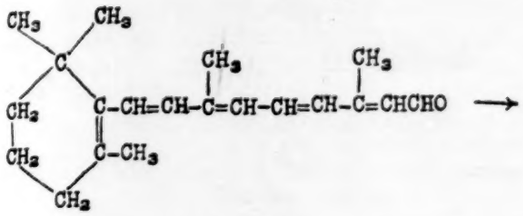
According to the principle of vinylogy[1] the condensation of β-cyclocitral (I) with two moles of

[1] A. Kusin, *Ber.* 68: 619, 1494 and 2169 (1935).

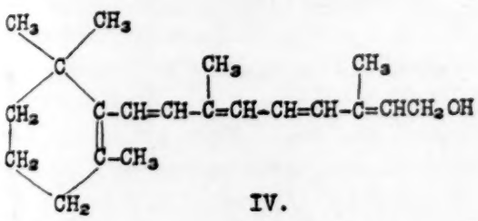
[1] Fuson, *Chem. Rev.,* 16: 1, 1935.



I. II.



III.



IV.

dimethylacrolein (II) should lead to the formation of the aldehyde III. The latter should yield IV when selectively reduced by the method of Ponndorf.[2] This alcohol has the structure ascribed by Karrer, Morf and Schöpp[3] to vitamin A.

We have condensed I with II and subjected the crude reaction product to the action of aluminum isopropoxide. The resulting solution gives a blue color when treated with antimony trichloride in chloroform —which is the standard test for vitamin A.[4] At appropriate dilutions of the synthetic material a color is obtained which is indistinguishable from that given by cod-liver oil.

The ultra-violet absorption spectrum shows a maximum in the region of 328 mμ. Biological tests for vitamin A activity are in progress.

REYNOLD C. FUSON
ROBERT E. CHRIST
Du Pont Post-doctorate Fellow, 1935–36

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF ILLINOIS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE REGAL LILY AS A SOURCE OF ROOT-TIP MATERIAL

OBSERVATIONS made in our laboratory indicate that the Regal lily (*Lilium regale*) furnishes root tips which are superior to any other generally available material for the study of mitosis. The root tips are secured easily by burying the bulbs in damp moss and keeping them at a temperature between 60 and 70 degrees F. Bulbs which are taken in September are mature and ready to begin growth when placed under favorable conditions. Keeping the bulbs in cold storage at a temperature of 34° F. for a period of three weeks resulted in slightly more rapid sprouting and growth, but did not cause any more root tips to be developed than grew from the bulbs which were not chilled.

The root tips of the lily vary greatly in size, some being only slightly larger than those of the onion, while others have a thickness of 3 to 4 mm. The number of primary root tips is usually small, 5 to 10 per bulb; but if the primary roots are allowed to grow, they soon produce numerous branches from which a much larger number of small tips can be secured.

Measurements of cells in the growing region of the Regal lily root tip show them to average 50 per cent. larger than the cells of the onion, and 20 per cent. larger than those of Tradescantia. The chromosomes and the mitotic figures of the Regal lily are also considerably larger than those of the other two forms. The average of measurements of chromosomes of onion, Tradescantia and Regal lily show a ratio of 1 : 1.28 : 1.44

The large size of the cells, and their organs, of the Regal lily permits cell structures to be seen with greater readiness than in any other root tips that we have examined. Our experience in the use of these as study material shows that the details of mitosis are more easily observed by students than in onion or Tradescantia root tips.

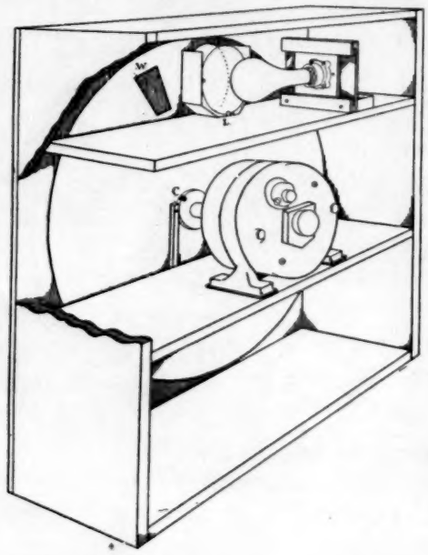
The Regal lily was discovered by E. H. Wilson growing on the hills of western China at an elevation of 2,500 to 6,000 feet, where seasonal temperatures are extreme, and strong winds blow at all seasons of the year. On being brought into cultivation it has proven to be a hardy and easily grown lily. It is completely fertile, producing large numbers of seeds which give almost 100 per cent. germination, and develop into blossoming plants in two years. The development of the embryo sac, seeds and pollen is normal. The pollen grains sprout readily in sugar solutions, and produce long pollen tubes with accompanying cell divisions. The ease with which the Regal lily can be grown in large numbers, its hardiness and its complete normality make it a useful and convenient plant for study and experiment.

LAWRENCE E. GRIFFIN
JANE DAY
REED COLLEGE

[2] Ponndorf, *Zeit. angew. Chem.*, 39: 138, 1926.
[3] Karrer, Morf and Schöpp, *Helv. Chim. Acta*, 14: 1431, 1931.
[4] *Pharm. J.*, 126: 466, 1931.

A SIMPLE DEVICE FOR SHORT PHOTOGRAPHIC EXPOSURES[1]

IN connection with some recent experiments on the deposit of insecticidal sprays on surfaces it became necessary to photograph the formation of droplets of spray on the object. This requires a short exposure and therefore high intensity illumination. Instead of controlling shutter speed the duration of illumination



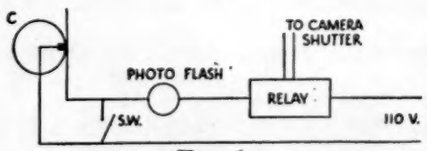


FIG. 1

was limited. The apparatus is shown in Fig. 1. A window, W, is cut in a sheet steel disk 2 feet in diameter directly fastened to the motor shaft. A window, not shown, is cut in the box so that it and the flash lamp and lens are in line. The window, W, thus serves as a shutter. If the speed of the motor is 1800 r.p.m., then one revolution requires 0.033 seconds and a window subtending 12° of arc will give a duration of illumination of 0.001 second. Since the maximum intensity from a photoflash bulb occurs about 0.01 seconds after firing, the commutator is set at 180° to 270° with respect to the window. Before the window has again passed the lamp the flash is over so that but a single exposure results. The number 20 size photoflash lamps give enough light to cover a square foot of surface.

The wiring diagram is self-explanatory. If desired, the relay may be dispensed with and the camera shutter operated by hand, using a one second time or "bulb" which permits of firing the light by switch during the exposure. The switch, S.W., is used when focussing the light on the object, an ordinary 100-watt lamp being substituted for the photoflash lamp.

RODERICK CRAIG

[1] From the laboratories of insect physiology and toxicology, Division of Entomology and Parasitology, University of California, Berkeley, Calif.

A SIMPLE LABORATORY-MADE BLAST LAMP

A SIMPLE flexible blast lamp may be easily constructed in a few minutes with material found in most laboratories. The outer jacket (A) may be made of 20 mm Pyrex tubing or a 20 mm Pyrex test-tube, to which is attached the side arm (B) for the gas intake.

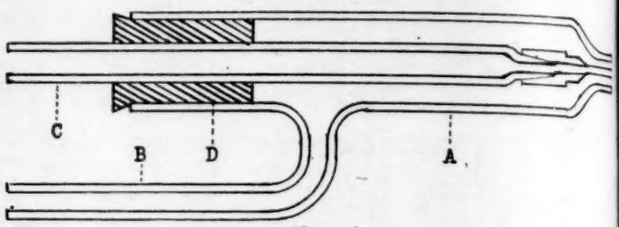


FIG. 1

The nozzle is then drawn out to about 3 mm inside diameter. The central tube (C) for oxygen supply is the barrel of a 1 cc tuberculin syringe, with the base flange removed. This is inserted through the cork (D). For the changeable oxygen tips, filed-off hypodermic needles are used. Thus by merely removing the syringe and cork, a needle may be slipped off and quickly replaced by another of a different size and the resulting flame may be varied from a fine point with a 20-gauge needle to a large lance flame with one of 13 gauge. The type of flame may also be varied from a point to a large "brush" annealing flame by slipping the syringe forward or back.

For very fine work, as quartz micro-manipulation needles, the nozzle may be drawn out to a finer opening and smaller tips used. The bend in the side arm makes the lamp convenient for use as a hand torch, while a ring stand and clamp make it a flexible bench type.

The only disadvantage to this blast lamp as described lies in the fact that both oxygen and gas must be regulated at the source. If desired, stop-cocks may be incorporated in the lamp itself.

C. ROBERT MOODEY
ARNOLD LOWMAN

UNIVERSITY OF CALIFORNIA MEDICAL SCHOOL

BOOKS RECEIVED

ERIKSON, HENRY A. *Elements of Mechanics.* Third edition. Pp. xv + 269. 143 figures. McGraw-Hill. $2.25.

HOLMES, HARRY N. *General Chemistry.* Third edition. Pp. viii + 700. 200 figures. Macmillan. $3.50.

HOUSTON, WILLIAM R. *The Art of Treatment.* Pp. 744. Macmillan. $5.00.

PEAKE, HAROLD, and HERBERT J. FLEURE. *The Law and the Prophets.* Vol. IX in series of *The Corridors of Time.* Pp. viii + 188. 53 figures. Yale University Press. $2.00.

PINCUS, GREGORY. *The Eggs of Mammals.* Pp. ix + 160. 33 figures. Macmillan. $3.75.

SHAW, SIR NAPIER, and ELAINE AUSTIN. *Manual of Meteorology. Vol. II, Comparative Meteorology.* Revised edition. Pp. xlviii + 472. 225 figures. Cambridge University Press, Macmillan. $10.00.